Department of Pesticide Regulation

Mary-Ann Warmerdam
Director

M E M O R A N D U M

Arnold Schwarzenegger
Governor

TO: Randy Segawa
Senior Environmental Research Scientist
Environmental Monitoring Branch

FROM: Pamela Wofford, Associate Environmental Research Scientist Original signed by
Environmental Monitoring Branch
(916) 324-4297

DATE: October 19, 2005

SUBJECT: FLUX ESTIMATION CALCULATED FROM A SPRINKLER APPLICATION OF METHYL ISOTHIOCYANATE

In 1993, the Department Pesticide Regulation conducted a study in Kern County to monitor off-site concentrations of methyl isothiocyanate (MITC) from a set-sprinkler application of metam-sodium (Wofford et al., 1993). The metam-sodium solution (Vapam®, ICI) was applied at the maximum label rate of 100 gals/ac (935 l/ha) to a fallow 19-acre (7.7 ha) field. Monitoring was conducted for 73.5 hours from the start of application at 19:40 on August 3, 1993. The application continued for a total of 6 hours. Immediately following application, only water was run through the sprinkler system for 1.5 hours to flush the sprinkler line and incorporate the metam-sodium into the soil and leave a water seal at the surface. The highest concentrations occurred during the application period. The half-life for the dissipation of MITC was estimated at 7.3 to 7.6 hours.

The application was modeled with the U.S. Environmental Protection Agency (U.S.EPA) Gaussian plume dispersion model, Industrial Source Short Term (U.S. EPA 1995). This memorandum refers to modeling analysis that was originally completed in 1999, but was not finalized. The modeled concentrations were then compared to the measured concentrations by regression analysis (Johnson et al. 1999, Ross et al. 1996) to back-calculate flux for the sampling intervals. The regression results and flux rates determined for each sampling period are presented in Table 1. With the exception of interval two, the regressions of the measured and modeled concentrations were significant at the p=0.05 level. The concentrations from interval two were sorted and reanalyzed to determine an estimate for the flux during the watering-in period. The highest flux for a single sampling interval was found during the 6-hour application period (interval 1).

The flux estimates were then inserted into the model with the field meteorological data to determine concentrations surrounding the fields during the first three individual sampling intervals. The contour graphs reflect the dispersion of the chemical away from the field due to air movement. The graph of the 6-hour application interval indicates three general directions of

highest concentrations (Figure 1). Figure 2 displays concentrations surrounding the application during the 1.5-hour watering-in period with strong wind directional movement toward the west. The modeling results of flux during interval 3 indicate that concentrations dispersed out in three directions. A 24-hour flux estimate was then calculated for the first 24-hour sampling period covering intervals 1 through 4.5 hours of interval 5. The estimated 24-hour time weighted average (TWA) flux rate was 185 µg/m^2/sec. The contour map indicates a more diverse pattern of chemical movement (Figure 4). Figure 5 presents a graph of the MITC concentrations and flux over time during the monitoring study. The graph shows a decline in concentrations and flux during the 1.5-hour watering-in period, and following an increase during the early morning hours following the application a general decline over time.

The amount of a chemical offgassing (emission) from an application area can be calculated using the estimated fluxes. The emission rate is calculated as a percent of the total amount of chemical applied to the application area. The application rate of 100 gals/ac of the applied product is equivalent to 318 lbs/ac metam-sodium active ingredient for a total of 6,042 lbs active ingredient applied to the 19-ac field. After an adjustment for the difference in molecular weight and an assumed 1:1 conversion of metam-sodium to MITC, the total MITC applied to the field is equivalent to 3,446 lbs.

Table 2 presents emission percentages, mass of MITC released and cumulative calculations during the monitoring study. A 24-hour TWA emission estimate was calculated for the first 24-hour sampling period covering intervals 1 through 4.5 hours of interval 5, and accordingly for the following two 24-hour intervals. During the first 24-hour period a total of 2,709 lbs of MITC was released. The total amount of MITC released from the application area during the monitoring period (73.5 hours) was approximately 3,049 lbs or 88.5% of the equivalent amount MITC applied to the field. Figure 6 displays the cumulative emissions and 24-hour TWA emissions (as percent of total MITC applied) during the 3-day monitoring. During the 6-hour application period (interval 1), 51.6 % of the applied MITC was released to the air. The emission during the first 24-hour TWA sampling interval was 78.6%, but declined during the next two days for a total of 88.5% emission from the field.

bcc: Wofford Surname File

REFERENCES

Johnson, B., T. Barry, and P. Wofford. 1999. Workbook for Gaussian Modeling Analysis of Air Concentration Measurements. Report EH99-03. State of California. Department of Pesticide Regulation.

Ross, L.J., B. Johnson, K.K. Kim and J. Hsu. 1996. Prediction of methyl bromide flux from area sources using the ISCST model. J. Environmental Quality 25(4):885-891.

U.S. EPA. 1995. User's Guide for the Industrial Source complex (ISC3) Dispersion Models. Volume 1. User Instructions. U.S. EPA Office of Air Quality Planning and Standards; Emissions, Monitoring and Analysis Division, Research Triangle Park, North Carolina.

Wofford, P., et al. 1994. Air monitoring for methyl isothiocyanate during a sprinkler application of metam-sodium. Department of Pesticide Regulation. Environmental Hazards Assessment Program Report 94-02.

Table 1. Regression analysis summary and cumulative flux during the study.

Sampling Interval	Duration (hrs)	Time of Day	r^2	F-test p-value	Flux ($\mu g/m^2/sec$)	Cumulative flux ($\mu g/m^2/sec$)	24-hr TWA Flux ($\mu g/m^2/sec$)
1	6	Night	0.54	0.015	486	486	
2	1.5	Night	0.65	**	53.1*	399	
3	6	Night	0.58	0.016	191	307	
4	6	Day	0.80	<0.001	24.7	220	
5	6	Day	0.90	<0.001	34.0	176	185
6	12	Night	0.91	<0.001	34.4	131	
7	12	Day	0.77	<0.001	4.16	100	21.1
8	12	Night	0.64	0.009	2.86	81.1	
9	12	Day	0.91	<0.001	0.850	68.0	2.06

*Concentrations were sorted before regression analysis.
**p value cannot be calculated using conventional statistics.

Table 2. Emission of MITC calculated from estimated flux.

Sampling Interval	Hours after start of application	TWA flux rate ($\mu g/m^2$-s)	TWA Emission (%)	Pounds of MITC released	Cumulative Emission (%)	24-hr TWA Emission (%)
1	6	486	51.6	1,777	51.6	
2	7.5	53.1	1.41	48.5	53.0	
3	13.5	191	20.3	699	73.3	
4	19.5	24.7	2.63	90.4	75.9	
5	25.5	34.0	3.61	125	79.5	78.6
6	37.5	34.4	7.31	251	86.8	
7	49.5	4.16	0.884	30.4	87.7	8.99
8	61.5	2.86	0.608	20.9	88.3	
9	73.5	0.850	0.181	6.22	88.5	0.88

Figure 1. Simulated MITC concentrations (µg/m^3) surrounding the field during application (Interval 1 - 6 hours duration).

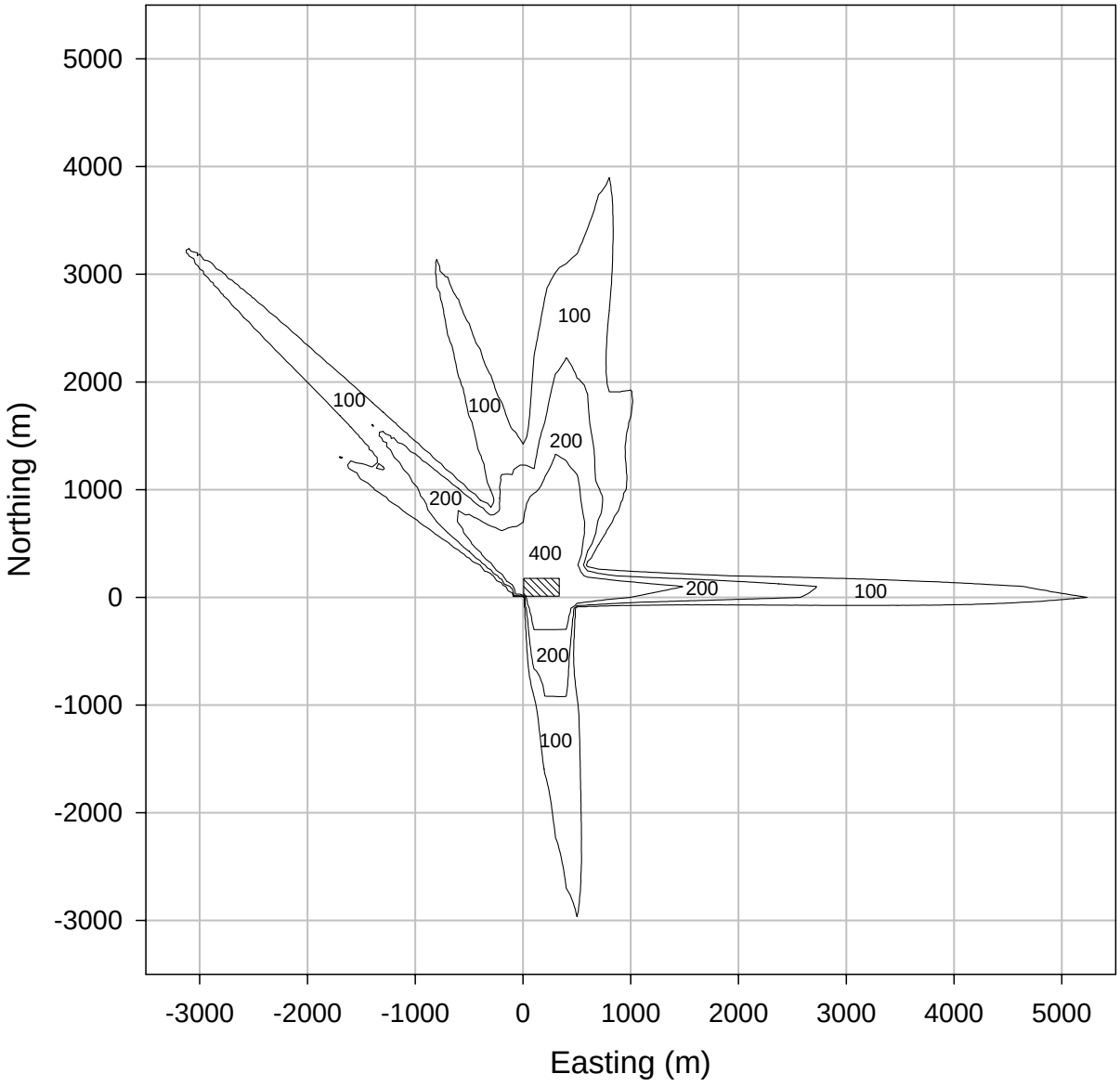

Figure 2. Simulated MITC concentrations (µg/m^3) surrounding the field during the water-in period following application (Interval 2 - 1.5 hours duration).

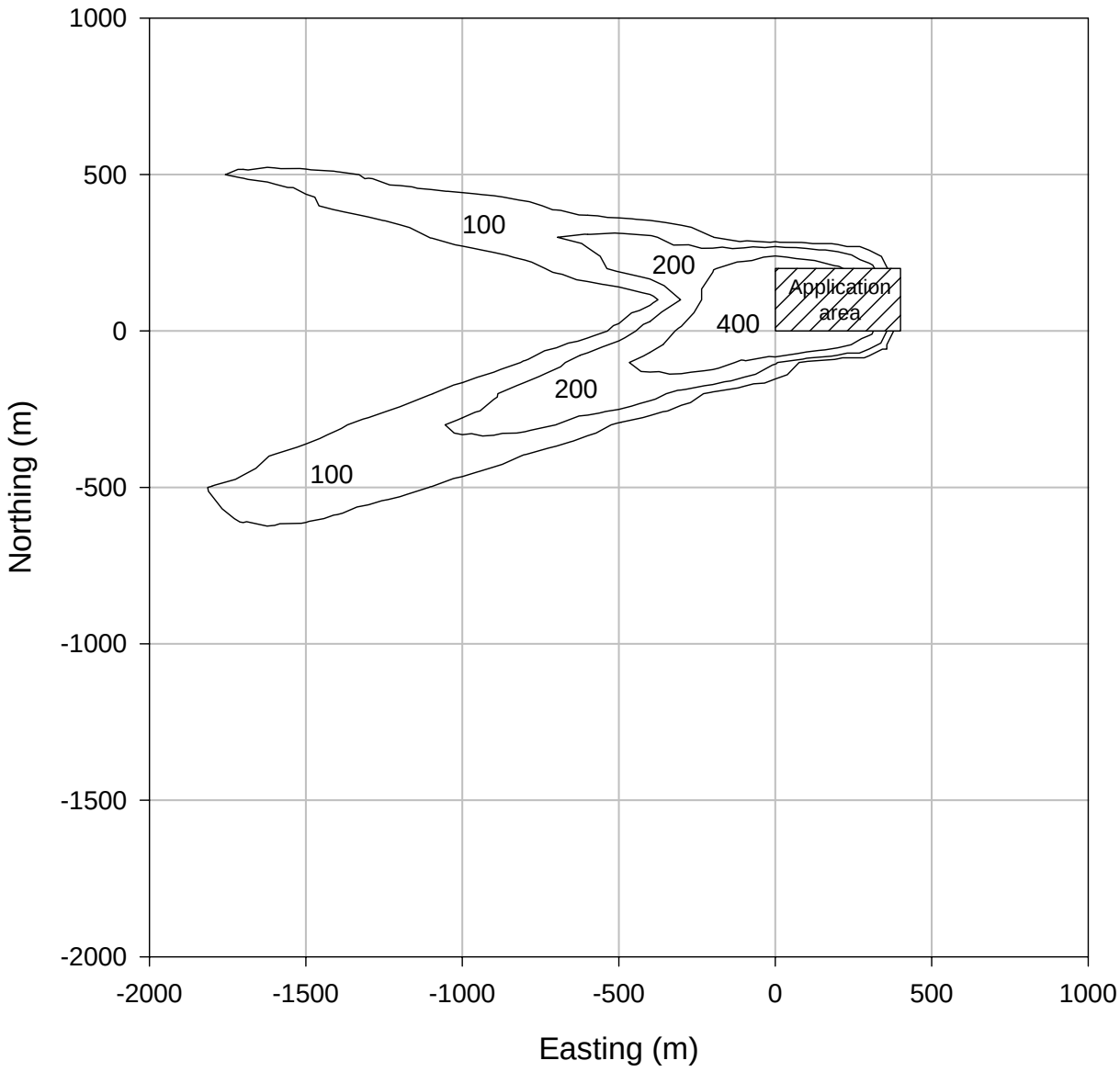

Figure 3. Simulated MITC concentrations (µg/m^3) surrounding the field during the third sampling interval (6 hour duration).

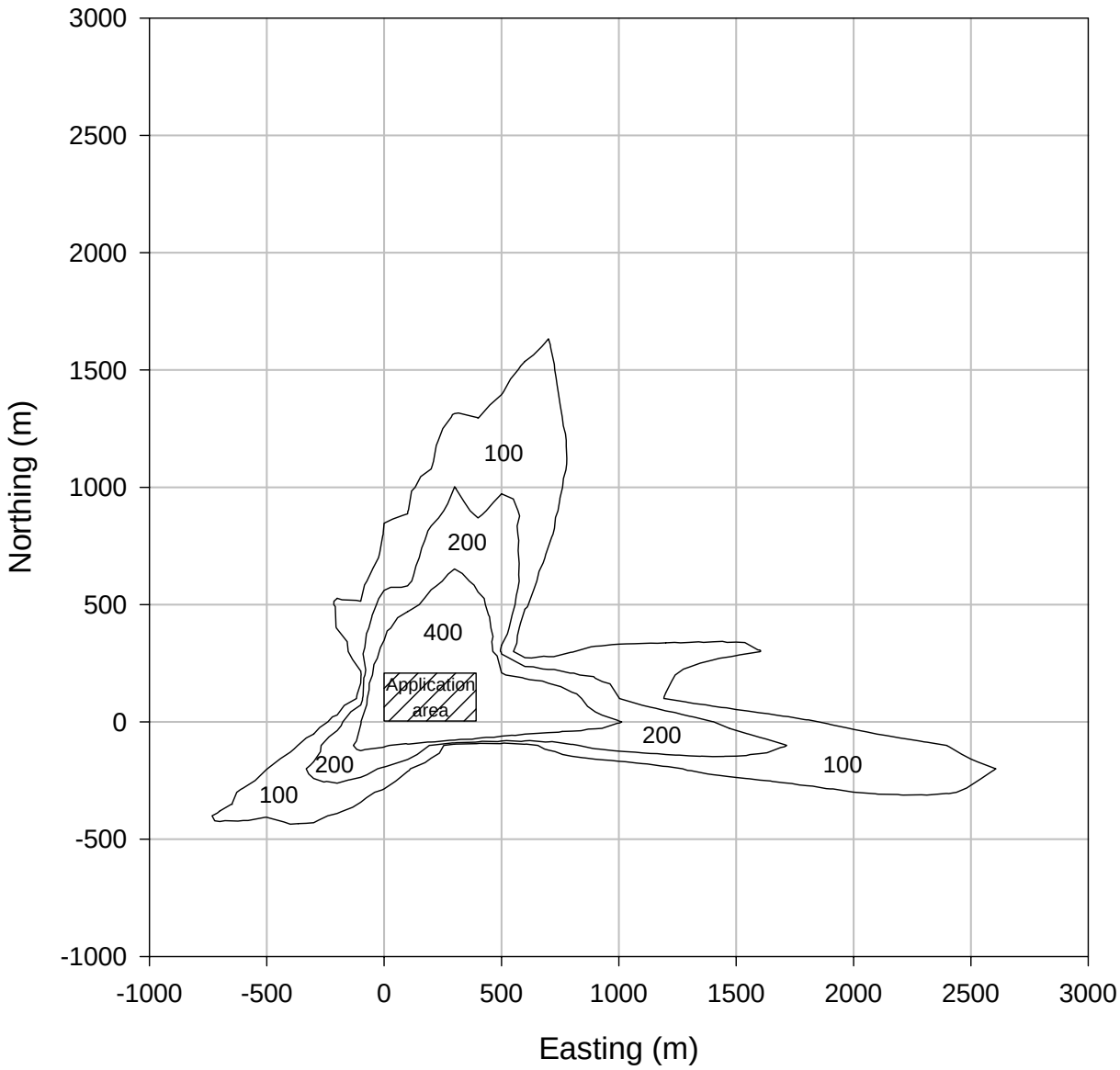

Figure 4. Simulated MITC concentrations (µg/m^3) surrounding the field during the first 24 hours following the start of application.

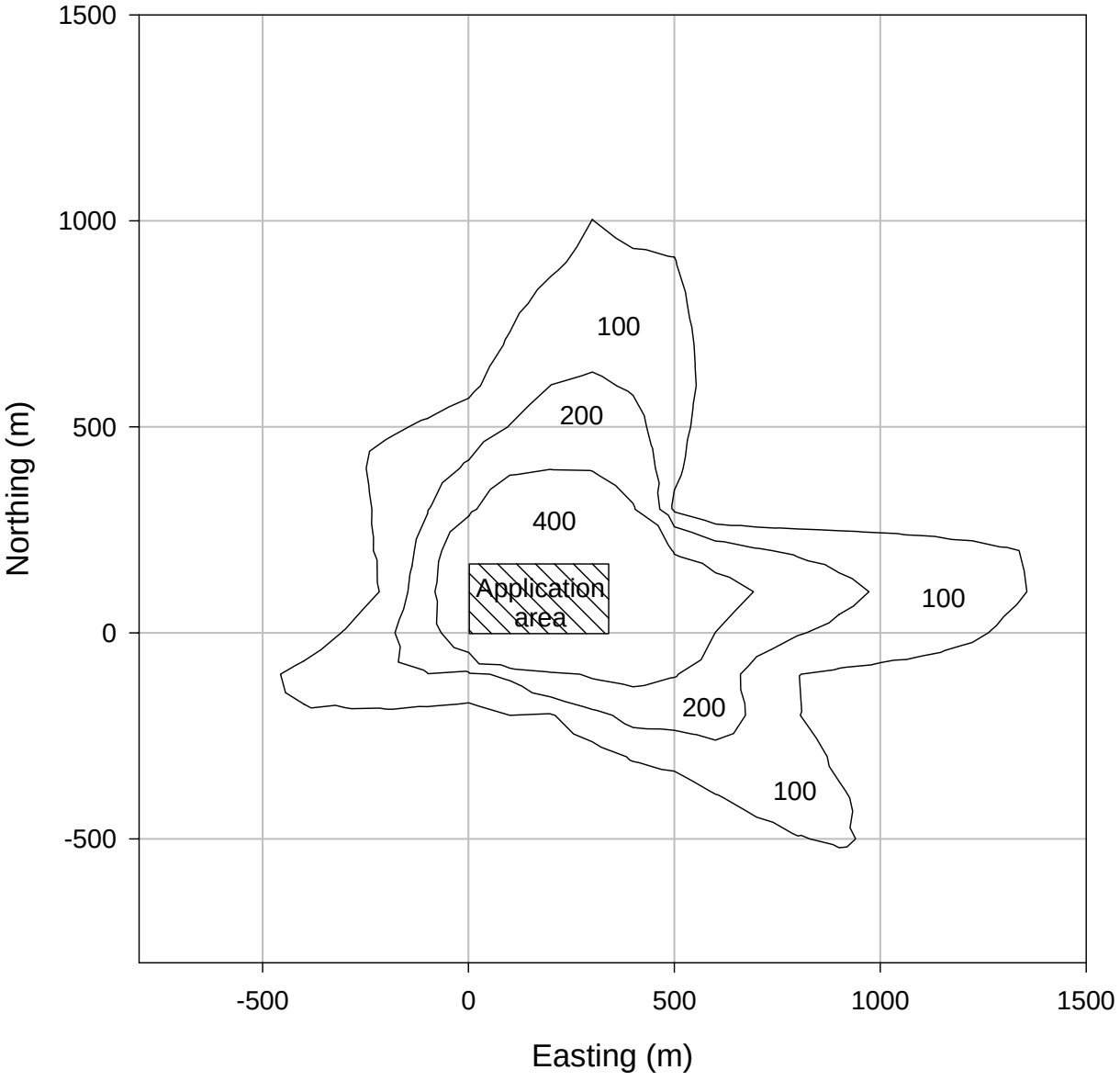

Figure 5. Maximum and average MITC concentration and flux.

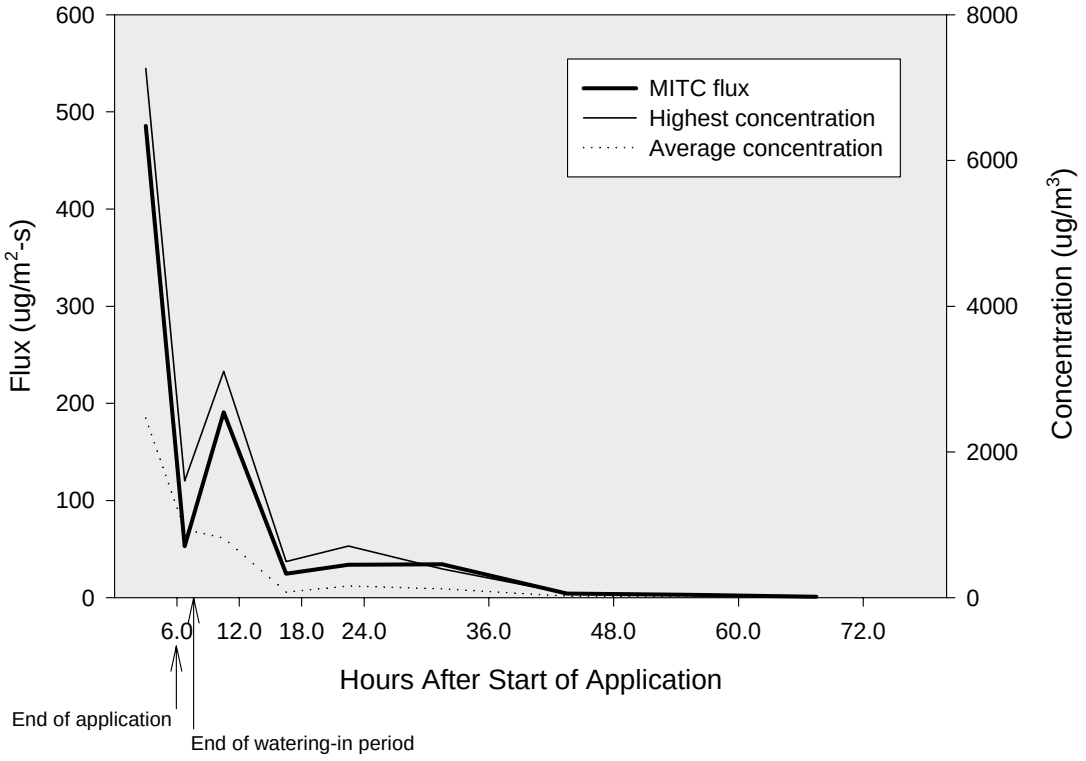

Figure 6. Cumulative emissions and 24-hour emissions (as percent of total MITC applied).